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DISTRIBUTIONAL WEIGHT FUNCTIONS AND ORTHOGONAL POLYNOMIALS

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Allaj M. Krall

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Annual Technical Report

(Final Report)

November 1, 1978 - October 31, 1979

Distributional Weight Functions
and Orthogonal Polynomials

Principal Investigator: Allan M. Krall

Title: Professor of Mathematics

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RESEARCH OBJECTIVES

It was proposed to

1. Examine the Cauchy representation of the Jacobi polynomial weight function to see what happens as the contour over which it is integrated approaches the interval $[-1,1]$ on the real axis. ($\alpha < -1, \beta < -1$).
2. Do the same thing for the Laguerre polynomials after the Cauchy representation has been found ($\alpha < -1$).
3. Examine the Pollaczek polynomials.
4. Examine other polynomial sets.

ACCOMPLISHMENTS, STATUS OF THE RESEARCH EFFORT

1. Preliminary calculations indeed bear out what was anticipated for the Jacobi Cauchy representation. This particular problem was put on a back burner when other more fruitful problems appeared.
2. Some of the Cauchy representations for $\alpha < -1$ were indeed found. Difference equations for different α 's were also derived, but a general formula remains elusive. This problem was likewise postponed when other more interesting problems were found.
3. Examination of the Pollaczek polynomials was made and proved either to be worked out or unfruitful for what it was supposed to provide in the way of information. It was a dead end that had to be explored and now is.
4. A distributional weight function on the real axis for the Bessel polynomials was improved upon.

Three new orthogonal polynomial sets were discovered satisfying fourth order differential equations. They resemble the Jacobi, Laguerre and Legendre polynomials, but have interesting differences. A complete study of these were made including their explicit forms, relations to the classical polynomials, recurrence relations, norms, orthogonality, Rodrigues formulas, Hilbert space settings and the expansions of arbitrary functions. The results were written up separately and then later combined in a rather lengthy article submitted to the Proc. Royal Soc. Edinburgh. These results were also presented at a special conference in Toronto, Ontario in July 1979.

The problem of which polynomial satisfy a second order differential equations was revisited with special emphasis on orthogonalizing functionals a survey article was written and has been submitted to the SIAM Review.

A weight function for the generalized Hermite polynomials $\{H_n^{(\mu)}\}_{n=0}^{\infty}$ was found when $\mu < -1/2$ (previously unknown). An article based on this research has been submitted to the Indiana J. Math.

A CUMULATIVE CRONOLOGICAL LIST OF WRITTEN PUBLICATIONS IN TECHNICAL JOURNALS

- (a) "On complex orthogonality of Legendre and Jacobi polynomials," Bull. Poly. Inst. Jassy. to appear
- (b) "Orthogonal polynomials satisfying a fourth order differential equation," Complete Rendus, Math. Rep. Acad. Sci. Canada 1(1979) 219-222.
- (c) "The Bessel polynomial moment problem," revised, improved and submitted.
- (d) "Orthogonal polynomials satisfying fourth order differential equations," submitted for publication
- (e) "Tchebycheff sets of polynomials which satisfy an ordinary differential equation," submitted for publication
- (f) "On the generalized Hermite polynomials $\{H_n^{(\mu)}\}_{n=0}^{\infty}$, $\mu < -\frac{1}{2}$."

LIST OF PROFESSIONAL PERSONNEL ASSOCIATED WITH THE RESEARCH EFFORT

Principal investigator: Allan M. Krall

INTERACTIONS

Invited lecturer at a differential equations conference in Toronto, Ontario in July-August 1979

NEW DISCOVERIES, INVENTIONS OR PATENT DISCLOSURES AND SPECIFIC APPLICATIONS

STEMMING FROM THE RESEARCH EFFORT

See the list of papers above.